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THE ECLIPSE EXPEDITION TO AUSTRALIA—FROM AUCKLAND TO PORT HEDLAND

BY C. A. CHANT

WE left Auckland, N.Z., on July 20th, on the *Manuka*, and reached Sydney on the 24th. The trip was moderately rough and on the last day a heavy north wind with rain came down upon us. We stepped off the ship in a deluge of rain, but we had not been ashore for more than fifteen minutes before a newspaper reporter found us and asked for an interview. With little difficulty we had our luggage passed through the Customs and a taxi soon landed us at our hotel.

We were in Sydney for six days and experienced the most generous kind of hospitality. Dr. Young and the writer paid several visits to the observatory and were pleased to meet its director, Professor W. E. Cooke, who was busy getting ready to observe the eclipse in Goondiwindi, in Queensland.

The president of the local branch of the British Astronomical Association is Mr. W. F. Gale, a well-known amateur and the discoverer of a comet about twenty-five years ago. Dr. Young and I attended one of their meetings and had the pleasure of talking to the members about our work in Canada. Mr. Gale (who is manager of the Government Savings Banks) possesses a fine 8-inch Grubb refractor and a 17-inch Calver reflector, and with these we had the pleasure of observing Mars, Alpha Centauri, Eta Argus and other interesting southern objects. On another day we had the honour of occupying seats on the floor of the Legislature of New South Wales and of meeting the premier, Sir George Fowler, in his office. Our whole party also had a motor-boat trip

in the Harbour, during which we paid a visit to St. Ignatius College at Riverview, where Father Pigott has a splendid installation of seismographs. We met many friends in Sydney, including members of the University staff, and were sorry to leave the great city.

We left Sydney on the evening of July 30th and reached Melbourne at 1 o'clock next day. We were met at the station by Mr. H. A. Hunt, Commonwealth Meteorologist, and Lieut.-Com. Quick, of the R.A.N., who is in charge of the transport of our expedition. In this splendid city, with its wide streets and imposing buildings, we spent three pleasant days, full of engagements. A drive about the water-front, visits to the University, the Observatory and the Botanic Gardens were greatly enjoyed. At the observatory is a 14-inch refractor by Grubb, a six-inch refractor finely mounted, an 8-inch meridian circle, and also the famous old 4-foot reflector made by Grubb about 1868 and pictured in many books on astronomy.

On August 3rd we again boarded the train, at 4.30 p.m., and at 10.10 next morning we reached Adelaide, the capital of South Australia. We were met at the station by Professor Kerr Grant, of the Adelaide University. On the trip across the Pacific Dr. Young and I had discussed our plans and had decided on certain apparatus to be made. With the generous permission of Professor Grant this was made in the University workshop. Adelaide is much smaller than Sydney or Melbourne, but it is extremely attractive. It has wide streets and very generous parks and public squares, and certainly most hospitable inhabitants.

Here we waited until the Lick Observatory party, consisting of Director and Mrs. Campbell and Dr. J. H. Moore of Mt. Hamilton and Dr. and Mrs. C. E. Adams of New Zealand, overtook us. They had reached Sydney on August 4th and after receptions in that city and in Melbourne had come on to Adelaide. Mr. J. B. Hosking of the observatory at Melbourne had joined the party there.

There was a great reception by the Lord Mayor at the Town Hall and after it a luncheon by the Commonwealth Club (like our Canadian Clubs) at which we all had seats of honour and Dr. Campbell spoke.

On August 13th we again boarded the train, this time to cross the continent. The railway for much of its way runs through an

unwatered waste, but the accommodation was good, the company agreeable and so the time went pleasantly. On August 15th at 11.45 we pulled into the great mining town of Kalgoorlie. We were met by the Mayor and others and escorted to the Town Hall where a civic reception was given to us. Then we drove out to see the racecourse, of which the citizens are very proud. When gold was found here, about 1896, the country was desert, and to allow the working of the mines the great project of pumping water 350 miles through 30-inch steel pipes was carried out. Truly it has made the desert to blossom like the rose!

In the afternoon we drove to the adjoining town of Boulder, where there was another civic reception, a visit to their racecourse and also to the "Golden Mile," on which are several famous gold mines. By this time we had to go to the station. We left at 5.15 and next morning reached Perth, the capital of Western Australia.

At this place was another series of entertainments including a splendid luncheon at Parliament House, at which the members of the Legislature and Council were present in full force. This was perhaps the finest of all the functions, though it is invidious to single out any one. The Canadian party owes a special debt of gratitude to Mr. J. J. Simons, the director of the Young Australia League, who was in Toronto in 1915 in charge of the Australian Cadets who visited us then. He had been informed of our coming and met us at the station, and during our stay made it very pleasant for us.

On Sunday, August 17th, we drove to Freemantle, the port of Perth, 12 miles away, and there went aboard the *Charon*, a good ship of 2,700 tons. It runs to Singapore and carries freight and passengers. We have stopped at Geraldton, Carnarvon, Onslow, Point Sampson (near Cossack) and are now at Port Hedland. The country and the loading and unloading are very interesting to us. We leave to-day for Broome, where we tranship to a schooner which will be towed to Wollal, on the Ninety Mile Beach.

This letter will be carried out by airplane to Geraldton where it will be transferred to the railway and go on to Perth and then to Sydney.

Port Hedland, W.A.,
August 27th, 1922.

THE STAR OF GREATEST KNOWN MASS

By J. S. Plaskett

Introduction

I HAVE been asked by the Editor to write for the Journal a short account of the very massive binary system recently investigated at Victoria. A paper on this star was presented to the Royal Astronomical Society and read at the June meeting, and this appeared in "Monthly Notices" for June. The complete spectroscopic orbit with observational data and discussion appeared in Vol. II, No. 4, Publications of the Dominion Astrophysical Observatory, and the only purpose of this article is to present in as non-technical language as possible for the many amateur readers of the Journal an authoritative account of what is known and can reasonably be deduced about this interesting system, especially as in the wide newspaper interest and publicity, entirely unsought by the writer, some erroneous conceptions have probably appeared.

After the completion of the first radial velocity programme of the observatory, it was deemed desirable, before undertaking another extensive programme, to complete some special investigations which appeared of importance and interest. Consequently Mr. Harper and Dr. Young undertook the determination of absolute magnitude and spectroscopic parallax of the stars observed here for radial velocity, Mr. H. H. Plaskett worked on intensity distribution in stellar spectra and on the physical interpretation of the spectra of O-type stars, while the writer decided to investigate the radial velocities of the absorption line O-type stars.

Stars of this spectral type are relatively few in number in the sky, less than one-tenth of one per cent., are strictly confined to certain parts of the Milky Way and are hence interesting on account of their rarity and their probable exceptional nature. They are distinguished by being the very hottest of the stars and by the presence in their spectra of lines due to the ionized atoms of helium, nitrogen, silicon and other non-metals. Among those already in-

vestigated the proportion of spectroscopic binaries was found to be higher while the spectroscopic orbits completed gave greater masses than in any other spectral class. One of the main reasons for investigating their radial velocities as a class was to determine the mass ratio wherever possible. I am indebted to the kindness of Miss Cannon in the preparation of the observing list which contains 49 stars, all the known Oe and Oe5 stars, 36 in number, within reach in declination at Victoria and sufficiently bright for spectroscopic observation with the 72-inch telescope. Thirteen others suspected for various reasons of being similar in type were included.

Orbit and Mass of System

The star B.D. 6° 1309, No. 2422 of the Harvard Revised Photometry and No. 47129 of the Henry Draper Catalogue, R.A. 6h 32.0m, Dec.+6° 13′ (1900), visual magnitude 6.06 is one of the additional suspected stars furnished by Miss Cannon. Its spectrum is classified as A5 in Harvard 50 but as Bop in the Henry Draper Catalogue, and in the remarks it is stated "Hβ is not seen as a distinct dark line and appears to be slightly bright. The lines are narrow. Line 4200.3 is strong". The first spectrum obtained on December 6th, 1921, showed doubled spectrum lines of spectral type about Oe5. As there was wide separation of the doubled lines this one spectrum was sufficient to show that the velocity range was unusually large and that the system was probably of great mass. Consequently spectra were obtained as frequently as possible, and by April 5th, 1922, when the star was getting pretty far west for observation, 30 spectra, sufficient to determine the orbit, had been secured.

The spectrum is different, although not markedly so, from any other O-type spectrum obtained and would be classed as about midway between Oe and Oe5. It contains strong lines of the Balmer Series of hydrogen, of the Pickering Series of enhanced helium and fair lines of enhanced nitrogen and enhanced silicon. The lines of ordinary helium are rather weak and there are traces of magnesium 4481 of oxygen and of carbon. The H and K lines of calcium which frequently behave abnormally in these high temperature stars are abnormal in this star, being sharp and very

strong and not sharing in the velocity displacements of the other lines. There are traces of emission lines or bands in the spectrum but many of the O's are similar in this regard. Were it not for the doubled lines and large displacement, there is nothing in the spectrum to indicate the extraordinary character of this system. The spectrum of the fainter component appears to be quite similar in type but weak and diffuse so that the velocity measures are difficult and uncertain. Consequently the elements of the spectroscopic orbit were obtained from the spectrum of the brighter component and the measures of the fainter only used to determine the total range of its velocity, necessary to obtain its mass.

After a dozen or so observations had been obtained it appeared as if the period was about 15 days and as, with the velocity range observed, this would mean a mass of over 100 times the sun, much larger than any previously obtained, observations were obtained as frequently as possible to check up this period. Further as it has been found here on two or three occasions that apparently long period binaries, on further analysis were shown to have periods slightly less or greater than a day, two observations per night, as widely separated as possible, were made on four nights. These duplicate observations and further trials with all the 30 measures showed conclusively that the period could not be near a day and there can be no doubt that the period obtained, 14.414 days, is the correct one. When the observations are plotted with this period as shown in the velocity curve, Fig. 1, all the residuals are satisfactorily small, the probable error of the velocity measure of a single plate being only about 5 km. per sec. The chance that the period is other than that found is hence negligibly small.

The spectroscopic orbit was determined in the usual manner from the twice measured observations and was corrected by least-squares resulting in the following elements:

Period	P	$= 14.414 \pm 0.016$ days
Eccentricity	e	$= 0.035 \pm 0.011$
Longitude of Apse	ω	$= 181°.95 \pm 2°.54$
Time of Periastron	T	$= 2{,}423{,}031.870$ J.D.
Velocity of System	γ	$= +23.94 \pm 1.4$ km.
Semi-amplitude Primary	K_1	$= 206.38 \pm 1.95$ km.
Semi-amplitude Secondary	K_2	$= 246.7$ km.
Projected Semi-Axis Major	$(a_1+a_2) \sin i$	$= 89{,}750{,}000$ km.

As previously indicated these elements were obtained from the measures of the primary spectrum and only K_2 was determined from the uncertain measures of the secondary.

From the usual formulae we obtain the following masses, always, however, containing the factor of the cube of the sine of the inclination of the orbital plane, which is indeterminable in spectroscopic binaries, and the resultant figures are hence minimum values of the masses.

$$m_1 \sin^3 i = 75.6 \odot$$
$$m_2 \sin^3 i = 63.3 \odot$$
$$(m_1 + m_2) \sin^3 i = 138.9 \odot$$

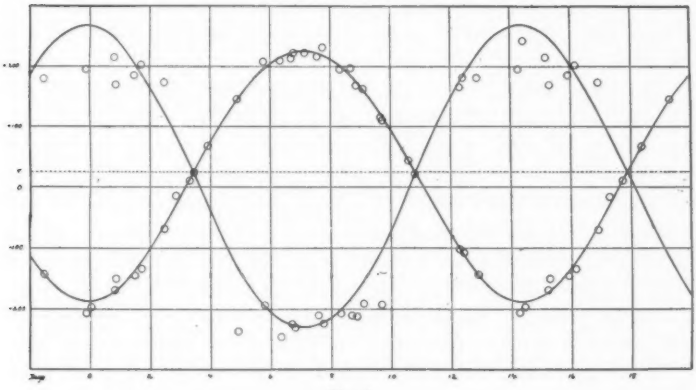


Fig. 1

It may be of interest to look at the determination of the masses in a different way. What is generally called the harmonic law offers a simple method of determining the masses of any revolving system. This law states that the combined mass of any such system is to the combined mass of a second system as the cube of the separation divided by the square of the period of the first system is to the cube of the separation divided by the square of the period of the second system, or $m_1 : m_2 = \frac{a_1^3}{p_1^2} : \frac{a_2^3}{p_2^2}$.

By taking the sun-earth system as the standard we find that these two stars revolve around one another neglecting the inclina-

tion of the orbit plane, at a separation of 89,750,000 kms. or .6003 the sun-earth distance in a period 14.414 days or .03946 years. Hence the mass of the system is

$$\frac{.6003^3}{.03946^2} = 138.9 \text{ times that of the earth-sun}$$

and as the mass of the earth is only about one three hundred and thirty thousandth of the sun it can be neglected and we get as before what might be called the projected mass $(m_1+m_2)\sin^3 i =$ 138.9 times the sun.

The mass is certainly greater than this value, for as will be seen later the diameters of these stars are probably about 20 and 18 times the sun and they are separated about 65 solar diameters. If the plane of revolution were nearly in the line of sight, the two stars would mutually eclipse every revolution, and we would have an eclipsing variable. As the variation of this naked eye star has not been observed, it is unlikely they eclipse and a simple calculation shows the orbit plane must be at least 17° from the line of sight or $i=73°$. At this inclination $\sin^3 i$ becomes 0.875 and the masses must be at least 14 per cent. greater making them 86 and 72 respectively and the total mass nearly 160 times the sun. If any inclination is considered equally probable the average value of $\sin^3 i$ is about 0.6 making the average value of the mass about 230 times the sun. It is perhaps a reasonable assumption, however, that the plane of the orbit is not markedly different from that of the Milky Way in which the star is situated, and hence that the value of 160 times the mass of the sun, more than four times greater than any previously determined, is the most probable. However, in the deductions to follow the actual computed values will be used.

Probable Brightness and Distance of System

It will be of interest to deduce from the known dimensions of this system as given by the spectroscopic orbit, the absolute magnitude of the two stars and hence from their apparent magnitude, the parallax or distance. Two methods of attack are open to us. The first is entirely theoretical, developed by Eddington* from considerations of the radiation pressure and the absorption in the

*Ap. J. 48, 211.

interior of a star, from which he deduces that the total radiation of a giant star is, for a given mass, inversely proportional to its opacity and otherwise independent of its density or stage of evolution. He obtains expressions from which the absolute magnitude for any mass can be obtained. From these formulae the absolute magnitudes become for

$$m_1 = 75.6 \odot \qquad M_1 = -6.25$$
$$m_2 = 63.3 \odot \qquad M_2 = -6.03$$

These are balometric magnitudes and to reduce to visual magnitudes requires for stars of this spectral type and temperature the addition of about +0.6 magnitudes, making absolute magnitudes in the usual units −5.65 and −5.4 and the total magnitude of the system −6.3.

The second method depends upon estimates of the surface brightness and surface area of the stars. Several determinations of the surface brightness of stars of different temperature or spectral type have been made by Russell, Eddington, Seares and others and the various methods agree fairly well. I have preferred to accept Russell's values as corrected by the results of interferometer measures of stellar diameter* which gives the surface brightness, brightness per unit area, of the Oe star 6° 1309 as about four magnitudes, forty times brighter than the sun. Considerations deduced by H. H. Plaskett in a recent paper† give the probable temperature of a star of similar spectral class to 6° 1309 as about 17000° K, and when this temperature is applied in formulae given by Seares‡ we get a surface brightness nearly the same as above.

With known mass, the density is required in order to determine the surface area. Estimates of the density, however, are subject to considerable uncertainty. We have reliable data of the density of early B's from eclipsing variables where the average density is 0.05 varying between 0.0004 and 0.18. This star is, however, at considerably higher temperature and considerably more massive and radiation pressure should tend to cause it to "blow out", become less dense. The star β Orionis is of the same order of brightness, and probably of mass, as 6° 1309 and some information

*A.S.P. *34*, 92.

†Pub. Dom. A'p'l Obs'y, Vol. I, No. 30.

‡Ap. J. 55, p. 197.

may be obtained from its probable density. The spectral type is B8 and the parallax 0″.007 makes its absolute magnitude −5.5 and it seems safe to assume, with the mass of 6° 1309 in mind, that its mass is 50 times the sun. The apparent diameter computed from Russell's corrected values* is 0″.0019 and this with a parallax of 0″.007 and mass 50 gives a density 0.002 the sun, while a smaller mass would give proportionately smaller density. Probably β Orionis is in the giant stage and the density of 6° 1309 must be greater. These considerations seem to indicate a probable density of 0.01 and as this is confirmed by extrapolating from Seare's values,† the values of absolute magnitude computed from this estimate can not be far from the truth.

With a mass of 75.6 and a density 0.01 times the sun, the diameter of the brighter component of 6° 1309 will be nearly 20 and its surface area 385 times the sun, which with surface brightness −4.0 magnitudes or 40 times makes its absolute brightness over 15,000 times the sun or −5.65 magnitudes. This value is in exact agreement with that obtained from theoretical considerations and while this is of course only accidental, it serves to confirm the substantial accuracy of the deductions, and to clearly show that this is not only the most massive but also the brightest known stellar system.

With a total absolute magnitude of −6.3, 27,000 times brighter than the sun and an apparent magnitude of 6.06 the parallax is easily calculated as 0″.00035, about 3,000 parsecs, 10,000 light years. Although the absolute magnitude is greater than any known system, the conservative estimate of density and the use of the minimum instead of the probable mass points to under rather than over estimate of magnitude.

Stationary Lines of Calcium

There is one other interesting feature about this extraordinary stellar system, the behaviour of the calcium lines *H* and *K*. As is well known in many spectroscopic binaries of the B-type with diffuse lines of hydrogen and helium, the lines *H* and *K* are very sharply defined and have a stationary or nearly stationary velocity

*A.S.P. *34*, 92.

†Ap. J. 55, p. 197.

displacement, not sharing in the oscillatory motions (due to orbital velocity) of the other lines. No satisfactory explanation, which will cover the varying behaviour of these lines in different stars, has yet been adduced and this particular star does not give much assistance in the problem. While the lines of hydrogen, helium, nitrogen and silicon in the atmosphere of the star oscillate back and forward with a range of over 400 kilometres, about 6 *A*, the *H* and *K* lines remain absolutely stationary with respect to the sun, giving a radial velocity of $+16.0 \pm 0.25$ km. per second. The probable error of the determination of the velocity of a single plate from these two lines is only ± 1.35 km. per second. This is remarkably small for single prism observations and shows conclusively that the calcium vapour which produces the lines does not shift its position as the two stars revolve around one another.

Two explanations have been offered for this general phenomenon of stationary calcium lines, one that the binary system has an outer surrounding cloud of calcium which either does not revolve with the system or else at a much reduced rate, and the other that there is an intervening calcium cloud in space. Neither one of these hypotheses suits all the observed cases, and it may be possible that some of the stars with stationary calcium lines have a surrounding cloud and some an intervening cloud or some other explanation may be necessary.

In the case of 6° 1309 it seems hardly possible that two such enormously massive bodies whirling around one another at velocities of over 200 km. per second should not induce some motion, which would be indicated by a radial velocity displacement in any near surrounding cloud. With a surrounding cloud also its velocity should be the same as the velocity of the centre of gravity of the binary system but in 6° 1309 the velocity of the cloud is $+16.0 \pm 0.25$ km. and of the system $+23.9 \pm 1.4$ km., the system receding from the sun 8 km. per second faster than the cloud. This difference would seem to rule out the hypothesis of the surrounding cloud, unless the line displacement equivalent to the 8 km. can be explained by some other cause than velocity. Errors in the wave lengths used and the effects of pressure are entirely inadequate to account for so great a difference, and this seems a case in which the relativity shift, which is in the right direction, might enter.

The three astronomical consequences of the general theory of relativity as stated by Einstein are—

1. The advance of the perihelion of Mercury's orbit.

2. The bending of light in passing near a heavy body such as the sun during eclipse.

3. The displacement of all the lines to the red in the spectrum of heavy bodies such as the sun or stars.

The first two consequences appear to be confirmed but the shift of the spectrum lines in the sun, where it should be equivalent to a velocity of +0.635 km., has not yet been definitely found. As this system is so much more massive than the sun the displacement, which is directly proportional to the mass and inversely proportional to the radius, should be greater. The relativity displacement for the bright component of 6° 1309, the component from which the orbital elements were determined, will hence be, according to the dimensions already obtained, $\frac{75.6}{19.5} \times 0.635 = +2.5$ km. To this is to be added the effect due to the fainter component 130 solar radii distant, +0.3 km., making +2.8 km. The calcium lines would also be shifted in the same direction but the probably great distance of either a surrounding or isolated cloud would make a negligible reduction. The maximum amount of the relativity displacement with the assumed value of the density is, therefore, only 2.8 km. as compared with the difference of 8 km. To have a relativity shift of 8 km. would require the inadmissible density of 0.4 times the sun for this very hot star.

The absolutely stationary lines and this difference in velocity seem to definitely rule out the hypothesis of a surrounding cloud in this star and make the assumption of an intervening cloud more probable. This assumption is strengthened by the curious fact that the velocity +16.0 km. is almost exactly identical numerically with the component in this direction of a solar motion of 20 km. per second. In other words the assumed intervening calcium cloud is stationary with respect to the system of stars from which the solar motion has been determined. A similar relation is found in the case of most of the Novae and in many of the stationary calcium lined binaries and seems to be a fairly general phenomenon giving support to the theory of stationary calcium clouds in space.

Summary

The principal known and deduced facts about this interesting system may be briefly summarized. It consists of two enormous suns, 10,000 light years away, each at a temperature of about 17,000° K., 30,000° F., revolving around one another at a distance of about 90,000,000 km., 55,000,000 miles in 14.414 days. The brighter, more massive of the pair, moves with a velocity of 206 km. about 130 miles per second, is of a mass at least 75 and probably

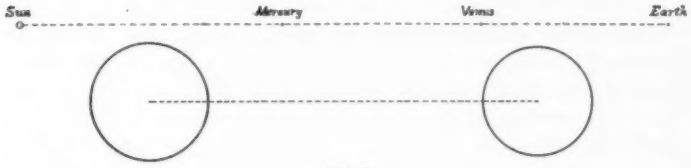


Fig. 2

about 90 times the sun, is 19.5 times the diameter and 15,000 times as bright. The fainter component moves with a velocity of 247 km., about 155 miles per second, is of mass at least 63 times and probably 75 times the sun, is 18 times the diameter and 12,000 times as bright. A graphical representation of the relative dimensions of the system as compared with the sun is given in Fig. 2. The system is moving away from the sun with a speed of 24 km. per second and the spectra show the presence of calcium vapour receding at the rate of 16 km. per second.

Dominion Astrophysical Observatory,
Victoria, B.C.
August, 1922.

A METHOD OF CALCULATING THE EXACT POINT OF INTERSECTION OF "SUMNER LINES" IN NAVIGATION

By Clarence E. Woodman

THE usual way of working a "Sumner" observation is to take an altitude of the sun, and, assuming two latitudes—one above and one below the supposed "dead-reckoning" latitude —to calculate a separate longitude for each assumed latitude, and to connect the points so found by a straight line on the chart. The ship must be somewhere on that line. Then, an hour or two afterwards, another altitude is taken, and two new longitudes are calculated, using the same assumed latitudes as before (unless the run of the ship has made too much northing or southing: in which case another pair of latitudes may be chosen.) These second longitude-points are likewise marked on the chart, and connected by a straight line. The ship must also be somewhere on this second line. Then, if necessary, the first line is brought up to the second, by allowing for and plotting down the course and distance run; and the intersection of the two lines must mark the ship's place at the second observation.

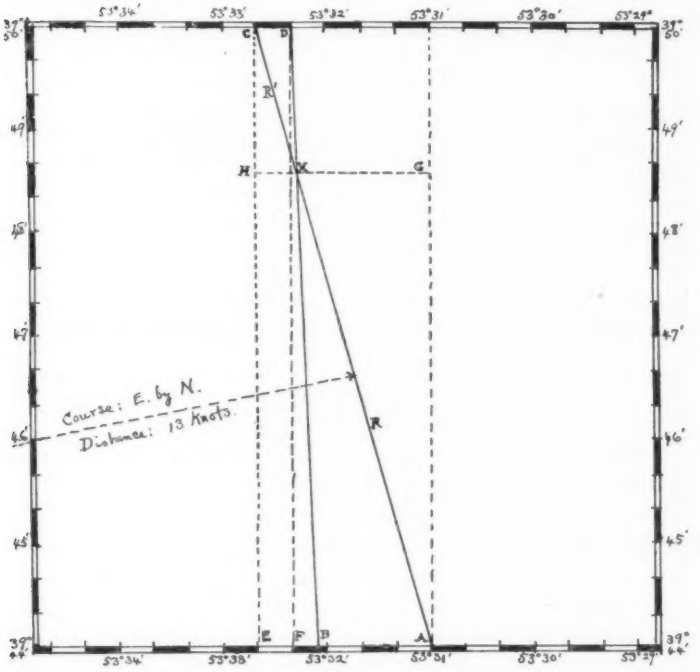
When the angle at the intersection of the two lines is over 45°, and the chart is on a large scale, and the ruler has a straight edge and the pencil a fine point, this method does very well. The resultant latitude and longitude will probably be correct within a minute or so. But when the angle is very acute the "fix" is not so good: the lines coalesce for some appreciable distance, and it is hard to tell just where the intersection really is. The "pencil-and-chart" method is a rough one at best; and so the following is suggested as a method whereby the intersection-point can be calculated (to the nearest second, if required) and all uncertainty avoided as to the precise "fix."

The accompanying illustration shows two Sumner lines, AC and BD, drawn on the chart: the assumed latitude being 39° 44′ and 39° 50′, and the resulting longitudes being in the first case

53° 30′ 59″ and 53° 32′ 39″, and in the second 53° 32′ 07″ and 53° 32′ 20″. The "fix" is somewhere around X—or about latitude 39° 48′ 40″ and longitude 53° 32′ 16″. To calculate this point exactly:

In the triangle ABX the angle A (or CAE) may be found by

$$\tan A = \frac{CE}{AE}.$$



But CE is the difference between the assumed latitudes, and AE is the difference between the first longitude at the first latitude and the first longitude at the second latitude. Again the angle B may be found by

$$\tan (180° - B) = -\tan B = \frac{DF}{BF}.$$

But $DF = CE$, the latitude-difference as before, and BF is the difference between the second longitude at the first latitude and the second longitude at the second latitude. Having found A and B, we get the angle at X by

$$X = 180° - (A + B).$$

This angle X, can be found at once, if the *azimuth* of the sun is observed at (or calculated for) the moment of each altitude-observation,—as the ordinary sea-practice; for this angle is, of course, the difference between the azimuths.

Now in the triangle ABX we get the side R by

$$R = \frac{AB \sin B}{\sin X}.$$

AB is known: as it is the difference between the first and the second longitudes at the first latitude. Having found R, we get AG, the *plus* latitude-correction, by

$$AG = R \sin A$$

and GX, the *plus* longitude correction, by

$$GX = R \cos A.$$

We can check these results by using the upper triangle, CDX (C, of course, being equal to A, and D to B), and getting R' by

$$R' = \frac{CD \sin B}{\sin X}$$

(CD is known: being the difference between the first and the second longitude at the second latitude.) So we get CH, the *minus* latitude-correction, by

$$CH = R' \sin A$$

and HX, the *minus* longitude-correction, by

$$HX = R' \cos A.$$

We have, therefore, the following rules:*

1. Divide the difference between the two assumed latitudes by the difference between the longitudes resulting from the *first* observation. The quotient is the tangent of an angle, which call A.

2. Divide the same latitude-difference by the difference between the longitudes resulting from the *second* observation. The

*Reduce all arcs to seconds. If the ship has moved in the interval, bring the first observation-line up to the place of the second, by Traverse Table in the usual manner.

quotient is the tangent of an angle, which call $180°-B$ (which is the same as *minus* tan B).

3. Subtract the sum of these angles, A and B, from 180°. The remainder is a third angle, which call X.

4. Multiply the sine of B by the difference between the longitudes resulting from the first and second observations at the *first* assumed latitude, and divide the product by the sine of X. Call the result R.

5. Then the true latitude is the least assumed latitude *plus* R sin A; and the true longitude is the least longitude at the first observation *plus* R cos A.

6. For a check: Multiply the sine of B by the difference between the first and the second longitudes at the *second* assumed latitude, and divide the product by the sine of X. Call the result R'. Then the true latitude is the greatest assumed latitude *minus* R' sin A, and the true longitude is the greatest first-observation longitude *minus* R' cos A.

EXAMPLE

At sea, at about half past three p.m., ship's time, the latitude by dead reckoning was 39° 46′ N. and the approximate longitude 53° 45′ W.; barometer, 29.80; thermometer, 82°; height of eye above sea, 26 ft.; index-error of sextant, −10″. The Greenwich mean time by chronometer was 7h 03m 34s.

Observed alt. sun's lower limb =	40° 49′ 00″	Index	= −00′ 10″
Correction = +	9′ 43″	Dip	= −05′ 00″
		Refraction	= −01′ 02″
		Semidiameter	= +15′ 48″
		Parallax	= +00′ 07″
True altitude sun's centre	= 40° 58′ 43″	Correction	= +09′ 43″
Sun's declination Greenwich noon =	+17° 25′ 21″.9	Hourly diff.	= 39″.58
		Elapsed time	= 7
Correction = −	4′ 37″.1	Correction	= 277″.06
True declination =	+17° 20′ 45″		= 4′37″1
Polar distance (P) =	72° 39′ 15″		
Equation of time Greenwich noon =	+5m 58s.85	Hourly diff.	= −0s.206
Correction = −	1s.44	Elapsed time	= 7
True equation of time	= +5m 57s.4	Correction	= −1s.442

To calculate the hour-angles (t) the ordinary "sine-formula" is used; viz:

$$\sin\tfrac{1}{2}t = \sqrt{\frac{\cos s \sin(s - \text{alt.})}{\cos \text{lat.} \sin p}}$$

(where s is the half-sum of the altitude, latitude and polar distance).

1st assumed latitude = 39° 44′		2d assumed latitude = 39° 50′	
alt = 40° 58′ 43″		alt = 40° 58′ 43″	
lat = 39° 44′ 00″ sec	= 0.11406	lat = 39° 50′ 00″ sec	= 0.11469
p = 72° 39′ 15″ cosec	= 0.02021	p = 72° 39′ 15″ cosec	= 0.02021
2 | 153° 21′ 58″		2 | 153° 27′ 58″	
s = 76° 40′ 59″ cos	= 9.36237	s = 76° 43′ 59″ cos	= 9.36076
s − alt = 35° 42′ 16″ sin	= 9.76612	s − alt = 35° 45′ 16″ sin	= 9.76665
2 | 9.26276		2 | 9.26231	
$\sin\frac{1}{2}t$	= 9.63138	$\sin\frac{1}{2}t$ =	9.63116
Local app. time	= 3h 22m 41s.6	Local app. time	= 3h 22m 34s.9
Equation of time	= + 5m 57s.4	Equation of time	= + 5m 57s.4
Local mean time	= 3h 28m 39s.0	Local mean time	= 3h 28m 32s.3
Green. mean time	= 7h 03m 34s.0	Green. mean time	= 7h 03m 34s.
Longitude in time	= 3h 34m 55s.0	Longitude in time	= 3h 35m 01s.7′
Longitude in arc	= 53° 43′ 45″	Longitude in arc	= 53° 45′ 26′

After the ship had run 13 knots, on a course E. by N., the first observed longitudes were brought up to the ship's place by the Traverse Table; giving for that course and distance a diff. lat. of 2′ 32″, and a diff. long. of 12′ 45″. This diff. lat. brings the dead reckoning latitude up to 39° 48′ 32″, and this diff. long. applied to the previously-found longitudes gives: for assumed latitude 39° 44′ a longitude of 53° 31′ 00″, and for assumed latitude 39° 50′ a longitude of 53° 32′ 41″. Thedifference between these longitudes is 101″.

Another sight was then taken, in d.r. lat. 39° 48′ 32″ and d.r long. 53° 32′ 15″, and the new altitude and polar distance used with the two assumed latitudes as before; the Gr. M.T. by chronometer being 8h 02m 12s.

Observed altitude lower limb	= 29° 29′ 20″	Index	= − 00′ 10″
Correction	= + 9′ 10″	Dip	= − 05′ 00″
		Refraction	= − 01′ 36″
		Sedidiameter	= + 15′ 48″
		Parallax	= + 00′ 08″
True altitude sun's centre	= 29° 38′ 30″	Correction	= + 09′ 10″
Sun's declination, Green. noon	= + 17° 25′ 21″.9	Hourly diff.	= 39″.6
Correction	= − 5′ 16″.8	Elapsed time	= 8

True declination	= +17° 20′ 05″	Correction	= 316″.8
Polar distance (p)	= 72° 39′ 55″		= 5′ 16″.8
Equation of time Green. noon	= +5m 58s.85	Hourly diff.	= − 0s.206
Correction	= − 1s.65	Elapsed time	= 8
True equation of time	= +5m 57s.2	Correction	= − 1s.648

1st assumes latitude = 39°44′

alt = 29° 38′ 30″	
lat = 39° 44′ 00″ sec =	0.11406
p = 72° 39′ 55″ cosec =	0.02019
2 | 142° 02′ 25″	
s = 71° 01′ 12″.5 cos =	9,51220
s − alt = 41°22′42″.5 sin =	9.82022
2 | 9.46667	
$\sin \frac{1}{2}t$ =	9.73333
Local app. time	= 4h22m06s.4
Equation of time	= + 5m57s.2
Local mean time	= 4h 28m 03s.6
Green. mean time	= 8h 02m 12
Long. in time	= 3h 34m 08s.4
Long. in arc	= 53° 32′ 06″

2d assumed latitude = 39° 50′

alt = 29° 38′ 30″	
lat = 39′° 50 00″ sec =	0.11469
p = 72° 39′ 55″ cosec =	0.02019
2 | 142° 08′ 25″	
s = 71°04′12″.5 cos =	9.51109
s − alt = 41°25′42″.5 sin =	9.82065
2 | 9.46662	
$\sin \frac{1}{2}t$ =	9.73331
Local app. time	= 4h 22m05s.5
Equation of time	= + 5m57s.2
Local mean time	= 4h 28m 02s.7
Green. meantime	= 8h02m 12s
Long, in time	= 3h 34m09s.3
Long. in arc	= 53° 32′ 20,

The difference between these longitudes is 14″.

Referring to the chart-diagram, we tabulate the necessary factors as follows:

$$AE = (53° 32′ 41″ − 53° 31 00″) = 101″$$
$$BF = (53° 32′ 20″ − 53° 32′ 06″) = 14″$$
$$AB = (53° 32′ 06″ − 53° 31′ 00″) = 66″$$
$$CD = (53° 32′ 41″ − 53° 32′ 20″) = 21″$$
$$CE = (39° 50′ 00″ − 39° 44′ 00″) = 360″$$

In triangle AEC,

$$\tan A = \frac{CE}{AE} = \frac{360}{101} \quad \begin{matrix} \log = 2{,}55630 \\ \log = 2.00432 \end{matrix}$$

$$\log \tan A = 0.55198$$
$$A = 74° 19′ 41″.8$$

$$-\tan B = \frac{DF}{BF} = \frac{360}{14} \quad \begin{matrix} \log = 2.55630 \\ \log = 1.14613 \end{matrix}$$

$$\log -\tan B = 1.41017n$$
$$B = 92° 13′ 37″.4$$

$$A+B=166^\circ\ 33'\ 19''.2$$
$$X=180^\circ-(A+B)=13^\circ\ 26'\ 40''.8$$
$$R=\frac{AB\sin B}{\sin X}=\frac{66\sin 92^\circ\ 13'\ 37''.4}{\sin 13^\circ\ 26'\ 40''.8}$$

$\log 66$	$=1.81954$
$\log \sin B$	$=9.99967$
$\log \operatorname{cosec} X$	$=0.63358$
$\log R$	$=2.45279 \quad R=283.65$

In triangle AGX,

$$AG=R\sin A, \text{ and } GX=R\cos A.$$

$\log R$	$=2.45279$		$=2.45279$
$\log \sin A$	$=9.98355$	$\log \cos A$	$=9.43157$
$\log AG$	$=2.43634$	$\log GX$	$=1.88436$
AG	$=273''.1=4'\ 33''.1$	GX	$=76''.6=1'\ 16''.6$
(the *plus* lat. correction)		(the *plus* long. correction)	

The true latitude, therefore, is $(39^\circ\ 44'+4'\ 33''.1)=39^\circ\ 48'\ 33''.1$, and the true longitude is $(53^\circ\ 31'=1'\ 16''.6)=53^\circ\ 32'\ 16''.6$.

CHECK

In triangle CDX,

$$R'=\frac{CD\sin B}{\sin X}=\frac{21\sin 92^\circ\ 13'\ 37''.4}{\sin 13^\circ\ 26'\ 40''.8}$$

$\log 21$	$=1.32222$
$\log \sin B$	$=9.99967$
$\log \operatorname{cosec} X$	$=0.63357$
$\log R'$	$=1.95546 \quad R'=90.25$

In triangle CHX,

$$CH=R'\sin A, \text{ and } HX=R'\cos A.$$

$\log R'$	$=1.95546$		$=1.95546$
$\log \operatorname{sim} A$	$=9.98355$	$\log \cos A$	$=9.43157$
$\log CH$	$=1.93901$	$\log HX$	$=1.38703$
CH	$=86''.9=1'\ 26''.9$	HX	$+24''.4$
(the *minus* lat. correction)		(the *minus* long. correction)	

These corrections are *subtractive* from the highest latitude and the greatest longitude respectively; and this operation gives thesame result as before: *i.e.*, true latitude $=(39^\circ\ 50'-1'\ 26''.9)=39^\circ\ 48'\ 33''.1$, and true longitude $=(53^\circ\ 32'\ 41''-24''.4)=53^\circ\ 32'\ 16''.6$.

This method is evidently well adapted for land observation, with transit or with sextant and artificial horizon. The approximate map-position is used instead of "dead reckoning"; and, as the observations are made in the same place, no allowance for "run of ships" is necessary. The degree of precision arrived at is limited only by the variant and inevitable inaccuracies of observation.

NEWMAN HALL, UNIVERSITY CATHOLIC CHAPEL,
BERKELEY, CALIFORNIA.

ALGOL: HOW TO OBSERVE ITS LIGHT-VARIATIONS

By J. A. Pearce

AS explained on page 26 of our Observer's Handbook, the times for the minima of Algol were computed from Chandler's formula with Hartwig's correction of 1h 30m earlier. It now appears that this correction is not sufficient and that the principal minima occur at least 3 hours earlier, *i.e.*, 1h 30m earlier than the times given in the Handbook.

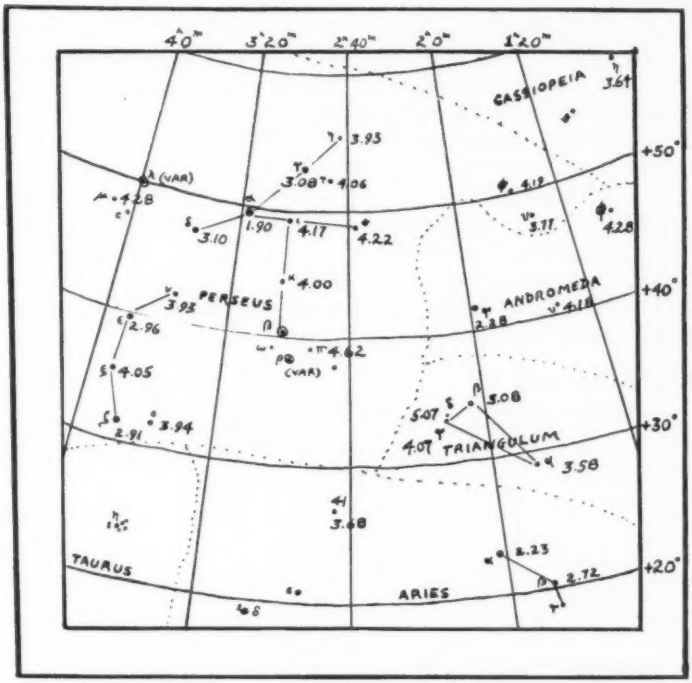
It is hoped that the following remarks may prove helpful to those members of the Society who have not heretofore observed variable stars, but who are willing to undertake regular observations on Algol.

The usual method of estimating the apparent brightness of a variable star is to look directly at the star for a few seconds until you have a distinct impression of its brightness free from momentary changes due to atmospheric disturbances. Then observe a comparison star in the same manner, and alternate, until you determine their relative brightnesses. If the two stars appear equally bright after a careful examination, or if the variable appears brighter than the comparison as often as it appears brighter than the variable, the magnitude of the variable is taken as that of the comparison. If after several comparisons the variable is definitely brighter than the comparison star, a second star is found whose brightness exceeds the variable by as much as it exceeds the first comparison star, and in this case, the magnitude of the variable is taken as the mean of the two magnitudes. If the two comparison stars differ as much as .4 of a magnitude, then taking .1 as a unit, the brightness of the variable is estimated as being, say, 3 units fainter than one star and 1 unit brighter than the other star. In this way it is possible to determine the brightness of a variable star to .1 of a magnitude.

The accompanying map shows the position of Algol and gives the magnitudes of the neighbouring stars. They are taken from

H.C.O., Vol. 50. Additional stars which may be used for the purpose of comparison are:

Alpha Cassiopeiae	2.47	Zeta Cassiopeiae	3.72
Beta "	2.42	Eta "	3.64
Gamma "	2.25		
Delta "	2.80	Alpha Andromedae	2.15
Epsilon "	3.44	Beta "	2.37



The magnitude of Gamma Andromedae should have been stated as 2.22, as this is the combined magnitude of the two components whose separate magnitudes are 2.28 and 5.08. Rho Persei is a variable and therefore should not be used as a comparison star. Comparison stars that differ by more than .6 of a magnitude should not be used to determine the brightness of a variable.

The light-oscillations of Algol occupy nearly ten hours, so that if possible the star should be kept under observation from 5 hours before the predicted time of minimum until 5 hours after that phase is reached. The observed time of minimum brightness may be taken as the mean of the times when Algol had the same brightness, before and after the minimum. Chandler in his Third Catalogue of Variable Stars, (*Astronomical Journal*, 1896), gives the period as 2d 20h 48m 54.4s+, and the range of variability as 1.2 magnitudes, from 2.3 to 3.5.

The Editor would be pleased to receive such observations as are made, and for the sake of uniformity it is suggested that the reports contain the following information:

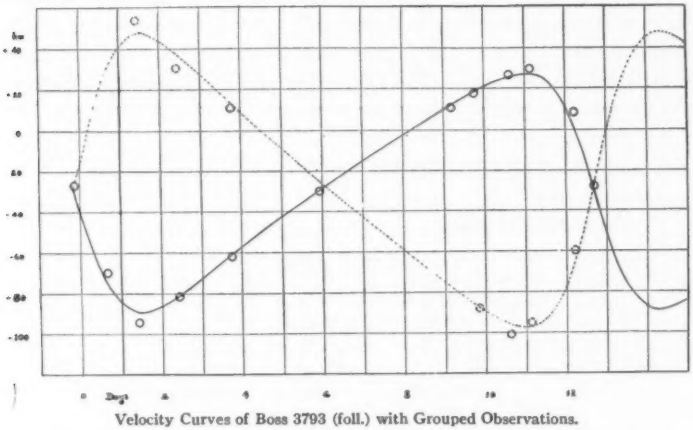
(*a*) Place of observation,
(*b*) Date,
(*c*) Observer,
(*d*) Observed magnitudes and times (E.S.T. expressed as a decimal of an hour),
(*e*) Comparison stars employed,
(*f*) Weather conditions, *i.e.*, quality of seeing, presence of the moon, of haze or of clouds, etc.

Lick Observatory,
Sept. 1st, 1922.

THE SPECTROSCOPIC ORBIT OF BOSS 3793 (FOLLOWING)

By W. E. Harper

THIS star (1900 $\alpha = 14^h\ 46^m.3$, $\delta = +49°\ 07'$, vis. mag. 6.8, type F5) was announcd as spectroscopic binary number 151 from this observatory. To the original three plates twenty-six have been added this year, but, owing to the partial superposition of the component spectra which characterize the star, three of these and one of the original three have been discarded. The final solution rests upon seven plates where the lines are single and eighteen which should show them as double, though the second component being somewhat the weaker was definitely measured on but twelve of these. All spectra were made upon Seed 30 plates using the single prism spectrograph at the Cassegrain focus of the 72-inch telescope.



Velocity Curves of Boss 3793 (foll.) with Grouped Observations.

Using the period of 12.822 days, arrived at by connecting up with the early measures, the observations were grouped into twenty normal places, eleven representing component I and nine component II. The least-squares solution resulted in considerable

improvement in the elements as the sum of the squares of the residuals for the normal places was reduced forty per cent. The probable error of a plate was ±2.9 and ±4.0 km. per sec. for components I and II respectively. In the accompanying graph the dotted curve represents component II.

The star whose spectroscopic orbit is thus determined is the fainter following star of the visual double 39 Boötis. The other preceding component of visual magnitude 5.6 and same type is distant about 3″.5. Its velocity from six accordant measures given in Vol. II, No. 1 of our *Publications*, is −32.0 km. per sec. Three accordant measures this year give the almost identical result of −31.9 km. per sec. The velocity of the system of the spectroscopic following star is seen from our final values to be −28.0 km. per sec., and this difference of 4 km. per sec. taken into consideration with a common proper motion might seem to suggest a physical connection. Dr. Aitken has kindly looked up the recent micrometer measures of the pair and he thinks there is practically no evidence of relative motion. Were such found an approximate value of its parallax could be obtained. A preliminary value of the absolute magnitude of the fainter star would be 2.5 corresponding to a parallax of 0″.014. The preceding star is intrinsically fainter, being about 3.0 absolute magnitude, which corresponds to a parallax of 0″.030.

Dominion Astrophysical Observatory,
Victoria, B.C.,
September, 1922.

FINAL ELEMENTS

P	= 12.822 days	
e	= .394	±.001
ω_1	= 97°.05	±2°.49
ω_2	= 277°.05	±2°.49
γ	= −28.23 km.	±0.57 km.
K_1	= 58.31 km.	±0.94 km.
K_2	= 72.19 km.	±1.42 km.
T	= J. D. 2,422,379.490	±.057 days
$a_1 \sin i$	= 9,450,000 km.	
$a_2 \sin i$	= 11,700,000 km.	
$m_1 \sin^3 i$	= 1.27⊙	
$m_2 \sin^3 i$	= 1.03⊙	

OBSERVATIONS OF BOSS 3793 FOLLOWING

Plate Number	Date	Julian Date	Phase	Component I				Component II			
				Vel.	n	Wt.	O−C	Vel.	n	Wt.	O−C
3672	1920 Feb. 22	2,422,377.026	10.358	+26.2	13	1.5	+2.7	−105.8	12	1.0	−12.4
3813	" 29	2,384.031	4.541	−37.2	10						
4155	Apr. 24	2,439.871	9.093	+ 8.3							
7205	1922 Feb. 23	3,109.999	12.477	−21.1	14	1.5	−6.5				
7226	" 25	3,111.934	1.590	−96.1	18	1.5	−7.3	+ 53.3	4	0.5	+ 5.9
7255	" 27	3,113.948	3.604	−67.5	11	1.5	−4.1	+ 9.4	1	0.5	− 5.6
7300	Mar. 17	3,131.013	7.847	−16.9	17						
7365	" 25	3,139.902	3.914	−53.0	15	1.5	+6.0	+ 13.1	1	0.5	+ 3.5
7382	" 26	3,140.985	4.997	−29.6	19	1.4					
7402	Apr. 3	3,148.853	0.043	−30.0	16	1.5					
7459	" 14	3,159.917	11.107	+27.2	11	1.0	+0.2	− 94.3	9	1.0	+2.7
7465	" 16	3,161.838	0.206	−35.4	15						
7507	" 24	3,169.881	8.249	−12.2	10						
7517	" 28	3,173.846	12.214	+ 8.5	3	0.5	+1.2	− 59.8	3	0.5	+4.8
7552	May 8	3,183.808	9.354	+13.4	17	1.5	0.0	− 82.6	6	0.7	− 2.0
7569	" 11	3,186.804	12.350	−21.1	11	1.5					
7582	" 14	3,189.757	2.481	−78.1	9	1.0	+2.0				
7586	" 14	3,189.922	2.646	−84.0	9	1.0	−6.0				
7605	" 25	3,200.798	0.700	−72.2	7	1.0	+5.0				
7660	June 12	3,218.723	5.803	−32.3	15	1.4	−0.3				
7685	" 17	3,223.756	10.836	+26.5	16	1.5	+0.1	− 95.7	9	1.0	+1.3
7723	" 26	3,232.718	6.976	−27.4	15	1.4					
7775	July 3	3,239.805	1.241	−93.0	17	1.5	−5.4	+ 54.4	5	0.5	+ 9.0
7782	" 4	3,240.725	2.161	−82.4	12	1.0	+2.3	+ 34.4	2	0.5	− 6.8
7792	" 11	3,247.747	9.183	+10.8	16	2.0	−1.0	− 71.2	4		
7799	" 12	3,248.725	10.161	+21.7	15	1.5	−0.7	− 91.5	11	1.3	− 0.1
7809	" 13	3,249.729	11.165	+31.7	9	1.0	+4.9	− 96.2	4	0.5	+ 0.6
7817	" 15	3,251.756	.370	−36.6	8						
7848	" 28	2,423,264.814	.606	−64.9	4	0.5	+8.5				

ASTRONOMICAL NOTES

The Velocities of the Stars, by Gustav Stromberg in the Publications of the Astronomical Society of the Pacific, August, 1922. See also Proceedings, National Academy Sciences, June, 1922.

This article is a statement in popular form of the results of a statistical treatment of the space velocities of 1,300 stars of types F to M. When the parallax of a star is known its cross proper motion can be converted into linear speed and a combination of this with its radial velocity determines its real or space velocity both in direction and magnitude. The recent volume of spectroscopic parallaxes issued by the Mount Wilson observers furnishes the data for the distances, and radial velocities were, for the most part, available also from their own spectra. Proper motions were taken from the Preliminary General Catalogue of Boss.

The author precedes this main theme by showing how the motion of the solar system through space varies according to the system of stars used. Its velocity is different for the giants to what it is for the dwarfs. Eight hundred giant stars give a solar motion of 18.8 km. per sec. while 415 dwarfs give a velocity of 31.7 km. per sec. towards a slightly different apex. The speedier stars also seem to move in a direction opposite to that in which the sun is moving.

If the 1,300 stars under consideration were to start at the same instant and move for one second with a velocity equal to and in the same direction as that calculated for each, then the study of the real velocities is equivalent to studying the star density in the cluster thus formed. He finds the F-stars are distributed nearly in accordance with Kapteyn's two-stream theory and one of these streams can be identified with the Taurus stream.

Using the galaxy as a xy-plane with the z-axis towards the pole he portrays the intersections of the resulting equifrequential surfaces (corresponding to each velocity) with each of these planes and these graphs convey to the eye the velocity distribution. One striking feature is that stars with high velocities avoid moving towards that part of the sky between Aquila and Cassiopeia.

W. E. H.

MEETINGS OF THE SOCIETY

AT TORONTO

The Society met in the Physics Building at 8 p m. on October 10th, the President in the chair.

Mr. W. R. Dunlop, 51 Gothic Avenue, Toronto, was elected a Member.

Mr. H. Horning gave predictions for the month. Owing to their nearness to the sun, Jupiter and Saturn are now not suitable for observation, and Venus is drawing also toward the sun. Mars now is not a very satisfactory planet to view, as it is far south.

The President spoke about the sunspot minimum of the present time. He also reported the probable success of Dr. Chant's expedition to W. Australia owing to satisfactory weather at the time of the eclipse.

Dr. Fraser reported that while in Parry Sound during the summer he thought that he detected a sound accompanying the Aurora.

The President stated that during his trip in the far North he had never been able to detect any such sound, although conditions were very suitable for detecting any sound that might come from the Aurora. He also pointed out that the Norwegian experts on the Aurora had failed to find any sound, and their measures of the altitude of the streamers, 30 km. and above, made it necessary that the sound produced would need to have great volume in order to be audible.

Mr. A. F. Miller described a red coloured Aurora that he had observed in past years and gave an opinion that the red colour may have been due to the rare gases of the atmosphere. He also reported a scarcity of sunspots during July, August and September. He finds that the belts of Jupiter are now more nearly equal in width than in the past year or two. His observations of Mars

during the summer were then given. He pointed out that Mars had never been especially well suited for observation this summer for our latitude, owing to the fact that it was too low in the sky. Mr. Miller observed Mars first on May 21st and during the summer had 65 nights of observation and he had made over 100 sketches. He found the best conditions in July. During July he had been able to see Meridian Bay, the Greenwich of Martian Longitude, and many other features, especially in the N. Hemisphere, bordering on the Pole Cap. At present Mars has become quite gibbous like a moon 9 days old.

NOTES AND QUERIES

Communications are Invited, Especially from Amateurs. The Editor will try to Secure Answers to Queries

Dr. A. C. D. Crommelin, writing in *Nature* of September 30th on the total solar eclipse of September 21st, says:

"It is well to point out that the test of the Einstein theory does not depend wholly on the results of this eclipse. The plates secured in the 1919 eclipse at Principe and Sobral settled definitely that at least the half-shift was present, while the two cameras with the best definition gave values very close to the Einstein value. Further, the star-field in that eclipse was the best along the whole extent of the ecliptic, the stars in the present eclipse being much fainter. There are, however, two circumstances that should add weight to this eclipse: (1) that some of the observers were pointing directly on the stars, avoiding the use of a cœlostat or other mirror; (2) that the plan was being tried of photographing another star-field during totality, thus obtaining an independent scale-value for the plates, which gives a much larger coefficient to the Einstein displacement in the equations of condition.

"Probably weeks or months must elapse before the Einstein results are to hand.

"The corona is said to have had four long streamers, one extending to three solar diameters, which is more than the average, though by no means a record.

"Prof. Chant reports that the shadow bands were photographed. Prof. Kerr Grant, of Adelaide University, made measures at Cordillo by the photo-electric cell of the relative brightness of the sun and the corona. The results, with this very sensitive instrument, should be more trustworthy than previous determinations.

"The next two total eclipses (1923, September, and 1925, January) are visible in the United States; 1926, January, in Sumatra, etc.; and 1927, in England and Norway."

A Comparison of Giant Stars.

Writing to the English Mechanic of July 14, 1922, under the heading—"The Star 'Plaskett' and Others", O. R. Walkey says: "The discovery of the masses of the 'Plaskett' binary reminds us of the many other giant suns tucked away in space, insignificant by their distance to our eyes and in their true dimensions discoverable only by the presence of a companion. It is unfortunate that Canopus has no known companion to enable direct measurement of what must be an exceptional, probably the greatest, mass. As it is, one can only estimate from the most likely parallax of .0065", or distant just 500 light years. On this basis, the abs. mag. becomes −6.75 (against −5.65 for the larger Plaskett star), the sun being +5.0. The mass of Canopus, from Eddington's formulae based on temperature and radiation pressure, thus becomes 118, compared with the 86-fold sun's mass for Plaskett Major. So, if we can accept the assumption, Canopus still holds first place."

Astronomers who enjoy poetry always find something to appreciate in the following lines by Byron:

> Sun of the sleepless, melancholy star,
> Whose tearful beam glows tremulously far,
> That show'st the darkness thou canst not dispel,
> How like thou art to joy remembered well!
> So gleams the past, the light of other days,
> Which shines but warms not with its powerless rays.
> A night beam sorrow watcheth to behold
> Distinct but distant; clear, but oh, how cold!

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